REMARKS

This is in response to the Office Action mailed 2/22/2010. Reconsideration of this application is respectfully requested in view of this response.

STATUS OF CLAIMS

Claims 1 and 16 are pending.

Claims 2-15 and 17-40 were previously cancelled.

Claim 1 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over the article to Trompenaars et al. entitled, "Culture for Business Series: Business Across Cultures," published 2/02/2004, hereafter "**Trompenaars**" in view of the article to Woolliams entitled, "A New Framework for Managing Change Across Cultures," published 2003, hereafter "**Woolliams**" in further view of the article to Manley entitled, "Understanding Organizational Culture and its Role in Organization Transformation and Development," hereafter "**Manley**".

Claim 16 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Trompenaars in view of Woolliams and further in view of Vilalti et al. (U.S. Patent 6,842,751), hereafter "**Vilalti**".

REJECTIONS UNDER 35 U.S.C. §103(a)

Claim 1 stands rejected under 35 U.S.C. §103(a) as being unpatentable over the article to Trompenaars et al. entitled, "Culture for Business Series: Business Across Cultures," published 2/02/2004, hereafter "**Trompenaars**" in view of the article to Woolliams entitled, "A New Framework for Managing Change Across Cultures," published 2003, hereafter "**Woolliams**" in further view of the article to Manley entitled, "Understanding Organizational Culture and its Role in Organization Transformation and Development," hereafter "**Manley**". Claim 16 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Trompenaars in view of Woolliams and further in view of Vilalti et al. (U.S. Patent 6,842,751), hereafter "**Vilalti**".

To be properly rejected under 35 U.S.C. §103(a), the cited references have to provide for each and every feature of the rejected claims. Applicants respectfully submit that the combination of Trompenaars, Woolliams, and Manley, and the combination of Trompernaars, Woolliams, and Vilati fails to teach or suggest many of the features of the rejected claims.

Trompernaars discloses methods for marketing across cultures, understanding different markets and customer needs in a wide range of cultural contexts, and how to approach and resolve the challenges they present. Trompernaars also discloses a new conceptual framework for dealing with the business implications of culture by providing a practical toolkit for managers and leaders by helping them develop a new mindset for working with and across cultures.

Applicants wish to note that many of the arguments presented in their previous response with regards to Trompenaars and Wooliams substantially applies to the current rejection.

Applicants agree with the Examiner's statement on page 9 of the Office Action of 02/22/2010 that Trompenaars and Woolliams does NOT distinctly disclose the following feature of Applicants' independent claim 1:

> "said pairs of alternatives statements reflecting an unevenly weighted right-versus-right spectrums in which said pairs of alternatives statements are displayed as end points on said right-versus-right spectrum consisting of at least five check boxes, the check boxes adjacent to the end point alternatives statements being labeled 100% and the middle check box being labeled 50/50, and with the remaining boxes corresponding to unevenly weighted answers between 100% and 50/50" (emphasis added)

However, Applicants respectfully disagree with the Examiner that the above-mentioned feature is taught in Manley. Specifically, the Examiner points to the Table and the corresponding FIG. 3 on page 346 of Manley as teaching such a feature. The Examiner's citations are provided below:

	Company A	Customer
TEAM	14	23
OPEN SYSTEMS	26	22
HIERARCHY	17	23
PRODUCTION	43	32

The Organizational Culture Characterization profiles for the two organizations are presented in Fig. 3.

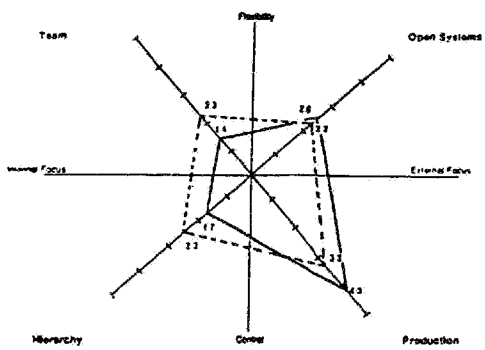

Fig. 3 Organizational Culture Profiles of Company A and Customer

To better understand the motivation behind the table and corresponding FIG. 3 of Manley, the Examiner is respectfully directed to review the first full paragraph on the column 1 of page 346, which is provided below:

Zammuto and O'Connor (1992) operationalized the competing values model by developing a questionnaire that they used to quantitatively characterize organizational culture. The questionnaire measures five dimensions: (1) organizational character, (2) the organization's managers, (3) organizational cohesion, (4) organizational emphases, and (5) organizational rewards. Data collected with the questionnaire allow the researchers to compute four overall scores for each of the competing values quadrants: TEAM, OPEN SYSTEMS, HIERARCHY, and PRODUCTION.

As the citation states, Manley relies on the paper by Zammuto and O'Connor for their teaching of the "competing values model" and it's associated "questionnaire" for quantitatively characterizing organizational culture. This is further strengthened by lines 1-4 of Manley, provided below, which specifically states that Manley "adopted" Manley's "structured questionnaire" in their research.

> In our work we have adopted an approach that is designed to utilize the strengths of both methodologies by combining Zammuto's structured questionnaire with qualitative data. To analyze the

To understand the "competing values model" and "questionnaire", Applicants have obtained a copy of the Zammuto et al. reference to further understand the "questionnaire" relied on by Manley. A copy of the Zammuto reference is provided in **Appendix A** of this response.

Zammuto's questionnaire, which is provided on pages 727-728, are questions that are merely a "survey instrument" that are used to "develop competing values (CV)" based upon a manual entry of points within each question. Specifically, Zammuto's questionnaire is based on "four value systems along four dimensions: institutional character, institutional leadership, institutional cohesion, and institutional emphases". Zammuto's questionnaire (which in turn is the basis of the questionnaire of Manley) is presented below:

1. Institutional Character (Please distribute 100 points)

——— Institution A is a very *personal* place. It is a lot like an extended family. People seem to share a lot of themselves.
——— Institution B is a very *dynamic and entrepreneurial* place. People are willing to stick their necks out and take risks.
——— Institution C is a very *formalized and structured* place. Bureaucratic procedures generally govern what people do.
——— Institution D is very *production-oriented*. A major concern is with getting the job done. People aren't very personally involved.

2. Institutional Leader (Please distribute 100 points)

——— The head of Institution A is generally considered to be a *mentor, a sage, or a father or mother figure*.
——— The head of Institution B is generally considered to be an *entrepreneur, an innovator, or a risk taker*.
——— The head of Institution C is generally considered to be a *coordinator, an organizer, or an administrator*.
——— The head of Institution D is generally considered to be a *producer, a technician, or a hard driver*.

3. Institutional "Glue" (Please distribute 100 points)

——— The glue that holds Institution A together is *loyalty and tradition*. Commitment to this institution runs high.
——— The glue that holds Institution B together is *commitment to innovation and development*. There is an emphasis on being first.
——— The glue that holds Institution C together is *formal rules and policies*. Maintaining a smooth running operation is important here.
——— The glue that holds Institution D together is the emphasis on *tasks and goal accomplishment*. A production orientation is commonly shared.

4. Institutional Emphases (Please distribute 100 points)

——— Institution A emphasizes *human resources*. High cohesion and morale in the institution are important.
——— Institution B emphasizes *growth and acquiring new resources*. Readiness to meet new challenges is important.
——— Institution C emphasizes *permanence and stability*. Efficient, smooth operations are important.
——— Institution D emphasizes *competitive actions and achievement*. Measurable goals are important.

According to Zammuto, respondents are asked to "<u>distribute 100 points among the four descriptions</u>" <u>for each of the four questions</u>. For example, a respondent might fill in 70 points for A, 30 points for B and 0 for C and D, respectively.

The Table pointed to by the Examiner on page 346 of Manley merely shows the competing value scores for two organizations based on various respondents' responses to a questionnaire that is similar to what is shown above in Zammuto. Further, FIG. 3 of Manley is

merely a graph that is drawn based on such competing value scores after the completion of the questionnaire.

However, it should be noted that both Manley and Zammuto merely teach a questionnaire that is manually filled in by respondents by assigning points for each choice (i.e., choice A, B, C, or D) for each of the four question (i.e., the questions relating to "institutional character", "institutional leadership", "institutional cohesion", and "institutional emphases"). However, it should be noted that both Manley and Zammuto fail to teach an unevenly weighted right-versus-right spectrums in which said pairs of alternatives statements are displayed as end points on said right-versus-right spectrum consisting of at least five check boxes, the check boxes adjacent to the end point alternatives statements being labeled 100% and the middle check box being labeled 50/50, and with the remaining boxes corresponding to unevenly weighted answers between 100% and 50/50. An example of such an unevenly weighted right-versus-right spectrum is shown in shown in Table 2 of Applicants' specification, which is partially reproduced below:

TABLE 2

	Examples of alternatives statement on a right-versus-right spectrum Right vs. Right Spectrums					
Alternatives	100%	99–51%	50/50%	51–99%	100%	Alternatives

Manley and Zammuto merely teach presenting four choices (i.e., A, B, C and D) for each question and asking each respondent to assign a point for each of the choices, wherein the assignments have to add to 100. There is no right-versus-right spectrum that is presented to the respondent, and there is no unevenly weighted right-versus-right spectrum presented to the

respondent. Further, there are no spectrums presented wherein both the end-points are labeled 100% with the middle checkbox labeled 50% and the remaining boxes presented to the respondents corresponding to unevenly weighted answers between 100% and 50/50.

Hence, at least for these reasons, Applicants respectfully submit that the art of record does not teach each and every feature of independent claim 1. Applicants, therefore, respectfully request the Examiner to withdraw the 35 U.S.C. §103(a) rejection with regards to independent claim 1 and further respectfully request allowance thereof.

The Examiner has rejected Applicants' claim 16 under 35 U.S.C. §103(a) as being unpatentable over Trompenaars in view of Woolliams and further in view of Vilalti et al. (U.S. Patent 6,842,751), hereafter "**Vilalti**".

The above-mentioned arguments with regards to Applicants independent claim 1 substantially apply to claim 16. Hence, at least for the reasons stated above, Applicants respectfully submit that the art of record does not teach each and every feature of dependent claim 16. Applicants, therefore, respectfully request the Examiner to withdraw the 35 U.S.C. §103(a) rejection with regards to dependent claim 16 and further respectfully request allowance thereof.

Further, Applicants are requesting clarification regarding the rejection of claim 16. Particularly, Applicants wish to note that claim 16 depends from independent claim 1, which was rejected using the combination of <u>Trompenaars</u>, <u>Wooliams</u> and <u>Manley</u>. However, dependent

claim 16 (which is dependent on independent claim 1) is rejected using the combination of Trompenaars, Wooliams, and Vilati, which suggests that the Examiner is NOT relying on the Manley reference. As the Examiner has already indicated that the combination of Trompernaars and Wooliams fail to show the unevenly weighted right-versus-right spectrums feature, Applicants respectfully request the Examiner to clarify wherein in the Vilati reference is there a teaching for such an unevenly weighted right-versus-right spectrums feature (that is described in detail in the previous discussion with regards to Applicants' independent claim 1).

SUMMARY

As has been detailed above, none of the references, cited or applied, provide for the specific claimed details of Applicants' presently claimed invention, nor renders them obvious. It is believed that this case is in condition for allowance and reconsideration thereof and early issuance is respectfully requested.

As this response has been timely filed, no request for extension of time or associated fee is required. However, the Commissioner is hereby authorized to charge any deficiencies in the fees provided to Deposit Account No. 09-0441.

If it is felt that an interview would expedite prosecution of this application, please do not hesitate to contact Applicants' representative at the below number.

Respectfully submitted,

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May 24, 2010

APPENDIX A

Gaining Advanced Manufacturing Technologies' Benefits: The Roles of Organization Design and Culture
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GAINING ADVANCED MANUFACTURING TECHNOLOGIES' BENEFITS: THE ROLES OF ORGANIZATION DESIGN AND CULTURE

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The literature on advanced manufacturing technologies (AMTs) shows that a wide range of outcomes have been experienced by organizations that have adopted these technologies, ranging from implementation failure to increased productivity and enhanced organizational flexibility. This article examines the roles that organization design and culture play in the varying levels of success experienced by AMT-adopting organizations. Several hypotheses are presented on the relationships among culture, structure, and implementation outcomes based on the competing values model of organizational culture.

Growing numbers of organizations are adopting advanced manufacturing technologies (AMTs) to cope with fragmenting mass markets, shorter product life cycles, and increasing consumer demands for customization. AMTs can help manufacturers compete under these conditions by enabling them to produce customized products at mass production cost. An *AMT* can be defined broadly as "an automated production system of people, machines, and tools for the planning and control of the production process, including the procurement of raw materials, parts, and components, and the shipment and service of finished products" (Pennings, 1987: 198). More specifically, AMT refers to a family of technologies that include computer-assisted design and engineering systems, materials resource planning systems, automated materials handling systems, robotics, computer numerically controlled machines, flexible manufacturing systems, and computer-integrated manufacturing systems. As Dean, Yoon, and Susman (1992) note, the common element among these technologies is the use of computers to store and manipulate data.

AMTs' benefits make them both similar to and different from earlier fixed-cycle and dedicated forms of automation. Like earlier automation technologies, AMTs increase productivity. However, AMTs differ from earlier technologies in their capacity to increase organizational flexibility because they are programmable, allowing them to produce a wide array

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of different parts or products in small volumes by changing software instead of replacing hardware. Their underlying information systems also make it possible for users to integrate formerly separate production functions into a single, interconnected system. Together, programmability and integration create *economies of scope*—the capacity to efficiently and quickly produce any of a range of parts or products within a family—as compared to earlier technologies' *economies of scale*—the ability to produce a large volume of one or a few products efficiently (Jelinek & Goldhar, 1984).

Several reports indicate that some organizations have gained AMT benefits. Ingersoll Engineers (1984), for instance, conducted case studies of seven U.S. organizations using flexible manufacturing systems (FMS) and reported an average 40 percent reduction in lead time, 30 percent increase in machine utilization, 12 percent reduction in unit cost, 30 percent reduction in labor costs, as well as product quality improvements and reduced work-in-process inventories. Similarly, Bessant and Haywood (1988) reviewed the experience of 50 FMS users in the United Kingdom and reported significant lead-time reductions, decreased work-in-process inventories, and increased machine utilization. And Ettlie's (1988: Chapter 2) extensive examination of a large number of organizations across six types of AMTs (computer-integrated design and its derivatives, group technology, robotics, flexible manufacturing systems, automated assembly, and computer-integrated manufacturing systems) showed similar gains. Case studies, such as O'Toole's (1985) report on Deere & Company and Goldstein and Klein's (1987) description of Allen-Bradley, also report successful implementation and increased productivity and flexibility.

However, the literature shows that organizations gaining benefits are more likely to experience productivity improvements rather than gains in flexibility. Voss (1988a,b), for example, examined the extent to which 14 organizations that had succeeded in technically implementing AMTs (getting them up and running reliably) also had experienced increased productivity and flexibility. Twelve of these organizations reported productivity improvements, but only eight had obtained other AMT benefits such as reduced lead times, increased product quality, and greater flexibility. Only two indicated that AMTs had improved their competitiveness. Similarly, Jaikumar's (1986: 71) study of 95 FMS sites found that, in U.S. organizations, "FMS boosted machine uptime and productivity, but it did not come close to realizing its full—and distinctive—strategic promise. The technology was applied in a way that ignored its huge potential for flexibility."

Moreover, there have been frequent reports about the difficulties experienced by manufacturers in gaining *any* benefits. For example, Fleck (1984) reported about half his sample of Australian manufacturers adopting robotics had implementation problems and about half of those subsequently abandoned the technology. Greenhalgh studied several AMT

projects involving 10 British manufacturers that had invested about 10 million pounds. He found that 40 percent of the technology had never been used or had been abandoned since implementation (cited in Bessant, 1985). A British Management Institute's survey of 239 companies found that 46 percent felt they were getting a poor or negative return on their investment in computer-aided design and computer-aided manufacturing technology, figures that rose to 67 percent for flexible manufacturing systems and 76 percent for robotics (New & Myers, 1986, cited in Primrose, 1988). Majchrzak (1988) estimated that the implementation failure rate of U.S. firms was in the 50 to 75 percent range. Consistent with these findings, a survey by De Meyer, Nakane, Miller, and Ferdows (1989) showed that successfully implementing new manufacturing technologies was among the top concerns of senior manufacturing executives and technical officers in U.S. and European companies. The difficulties in implementing these technologies also appear to be decreasing managerial enthusiasm for them. Only 29 percent of the respondents to a survey by Deloitte and Touche of 759 senior executives in North American manufacturing firms expressed a belief that the use of AMTs yields "significant" benefits (Sheridan, 1990).

Overall, the literature shows mixed results regarding the outcomes of implementing AMTs. A significant proportion of adopting organizations have experienced increased productivity; fewer appear to have increased their flexibility. And many report implementation failure, gaining neither AMTs' productivity nor flexibility benefits. This article examines the roles that organization design and culture play in the varying levels of success experienced by organizations that adopt AMTs. There is growing consensus that flexible organization structures are required to gain the benefits of AMTs (e.g., see Bessant & Buckingham, 1989; Ettlie, 1988; Majchrzak, 1988; National Research Council, 1986; Walton, 1989). Although our analysis is consistent with this consensus, we also suggest that the flexibility benefits ascribed to AMTs are not solely attributable to these new technologies. We suggest that such benefits are, in fact, the outcome of using flexible structures to implement AMTs. If an organization's structure is responsible for some of the benefits ascribed to AMTs, then it follows that an organization's culture can facilitate or hinder the implementation of an AMT. The implications of this statement are developed using the competing values model of organizational culture. Several hypotheses are presented concerning the likelihood of when an implementing organization will gain the productivity and flexibility benefits associated with AMTs.

ORGANIZATION DESIGN AND AMTs' BENEFITS

AMTs are a double-edged sword because they impose organizational challenges as well as provide competitive benefits. These challenges are associated with the increased complexity and interdependence of an AMT

operation, which, in turn, increases managerial uncertainty and may account for the implementation difficulties and failures reported by many organizations (Cummings & Blumberg, 1987). For example, productivity benefits derive from the incorporation of routine tasks into an AMT's hardware and software, which lowers direct labor costs, rework costs, and work-in-process inventories and increases machine utilization. At the same time, however, eliminating routine tasks effectively intensifies the complexity in the remaining jobs because the production hardware, its software, and their maintenance impose more complex technical requirements than most earlier production technologies (Buitendam, 1987; Dean & Susman, 1989).

Flexibility benefits derive from the electronic integration of the production process—both within functions (e.g., across different manufacturing tasks) and across functions (e.g., among design, engineering, and manufacturing). Integration shortens lead times, encourages design for manufacturability, and makes feasible the production of small batches of customized goods. At the same time, however, closer integration increases interdependence within and across organizational subunits, increasing coordination costs because of the need for mechanisms that encourage quick adjustment to variations in the workflow.

The combination of automation and integration magnifies the effects and costs of errors in the production process (Hayes & Jaikumar, 1988). Undetected problems in one area can rapidly cascade through an integrated production system and cripple it (Ebers & Lieb, 1989; Gerwin & Leung, 1980). Complex automated systems also have a tendency to experience unpredictable problems that are difficult to diagnose and resolve (Cavestro, 1989; Perrow, 1984), adding to the uncertainties that an AMT-adopting organization faces.

Organizations have employed a wide range of structural options in dealing with the increased complexity, interdependence, and uncertainties that accompany AMTs. Ettlie (1986), for example, discussed the diversity of administrative accommodations made by at least half of the *Fortune* 500 firms in their efforts to gain AMTs' benefits. The design strategies available to managers implementing AMTs can be portrayed as forming a continuum ranging from those that are control oriented to others that are flexibility oriented. These strategies differ in their underlying approaches to managing the uncertainties associated with AMT operation and with the resulting structures employed by organizations. The fundamental difference between them lies in the location of expertise and access to information within an organization. Control-oriented strategies push knowledge and access to higher organizational levels, whereas flexibility-oriented strategies push such expertise and information to lower levels.

Control-Oriented Design Strategies

Control-oriented design strategies attempt to consolidate managerial control over the uncertainties associated with AMT operations by central-

izing operational decision making in the hands of middle managers and technical specialists. Routine tasks are performed by the technology, simplifying the remaining production jobs, which increases managerial control by decreasing production employees' discretion. Kelley's (1986) description of the shop floor in an FMS-adopting firm in the metalworking industry shows how a control-oriented design strategy resulted in simplified production jobs and reduced the discretion of production employees.

> At the top of the occupational hierarchy are *system programmers* who worked in a central control room overlooking the shop floor. On the floor, *operators* check gauges, oil machines, and replace broken drill bits. *Laborers* feed machines and unload materials. *Maintenance workers* check and repair machinery. With the exception of the programmer's job, workers on the FMS were reported to follow only routine procedures in executing tasks (Kelley, 1986: 233, emphasis added). . . . Workers' discretion in varying the pace of work on an hour-to-hour basis is reduced: the speeds and feeds by which the machinist formerly controlled how fast or slow a conventional machine completed a job are set in the "program" which directs the machine's operation. (Kelley, 1986: 225)

This design strategy assumes that the transparency of work processes created by an AMT's underlying information system enables middle managers and technical specialists to recognize and deal with all key variances in the production process (Susman & Chase, 1986). How AMTs make manufacturing processes more transparent is illustrated by the comments of one former plant manager cited in Zuboff's study.

> The new base of instrumentation makes a hierarchical control system possible. These data summaries made available by the microprocessors can be fed into second-level controls that can actually substitute for operator monitoring and intervention. These data can be fed to a third level that summarizes the entire plant and becomes the basis for management control, analysis, and planning. This gives us the maximum opportunity to link the instrumentation directly with the computer and take the human interface out of the process. (1988: 246)

The result, in Burns and Stalker's (1961: 120) terms, is to develop highly mechanistic organization structures where coordination and problem resolution occur at higher levels within an organization's hierarchy because that is where expertise and information are believed to be located.

The control-oriented approach may well lead to increased productivity. Fewer and less skilled production employees are required to operate the system. These changes lower direct labor and training costs and minimize the negative impact of turnover as employees become easier to replace. Reduced work-in-process inventories and increased machine utilization increase productivity as well.

However, the control-oriented design strategy has its drawbacks. The

boredom, apathy, and alienation that typically accompany highly specialized jobs with little discretion can result in high levels of turnover and absenteeism. Overhead also increases because of the need for a centralized programming staff and a cadre of middle managers to supervise AMT operations (Gupta, 1989; Susman & Chase, 1986). Employees also may resist the de-skilling of their jobs and resulting loss of occupational status (Leonard-Barton, 1988), making implementation more difficult.

In addition, employees in highly specialized production jobs are unlikely to recognize problems as they occur because of their limited understanding of the overall production process (Liu, Denis, Kolodny, & Stymne, 1990). Nor are these employees likely to have the authority to correct problems as they occur because according to such a mechanistic structure, "nonconformance to procedures [is seen] as a source of 'human error' that contributes to system breakdowns and delays, rather than as a resource for adaptive solutions to system problems" (Kelley, 1986: 237). As a result, problems must be detected and corrected through the management hierarchy, which assumes that middle managers and technical support staff can recognize and deal with all key variances in the production process, either by writing software or taking "real-time" action to correct them (Susman & Chase, 1986). Developing such capabilities is a nontrivial task.

> Without machine operators physically handling parts, there is no one to realign them in a fixture, tweak cutting tools, or compensate for small machining or operational errors, and nobody to inspect parts for holes, cracks, or other material defects. To replicate a machinist's talent for recognizing errors, engineers and supervisors of an automated system need either an elaborate data base incorporating, say, an expert system incorporating the implicit rules of the skilled machinist, or a scientific understanding of the technology itself. Process engineers must provide the system sensors to detect errors and programmed controllers to interpret the sensors' signals and initiate corrective actions or shut down the machine. (Hayes & Jaikumar, 1988: 78)

Unless managers and their technical support staff have an almost omniscient understanding of the production process that allows them to closely supervise and control it, small problems accumulate quickly and become major ones because of an AMT's electronic integration.

Moreover, the control-oriented approach can hinder implementation because AMTs are not turnkey systems (Walton, 1989). These systems must be customized to the specific organizational settings in which they are installed. Centralization of responsibilities reduces opportunities for organizational learning, which, in turn, can make it more difficult to get an AMT up and running reliably.

Flexibility-Oriented Design Strategies

Flexibility-oriented design strategies attempt to compartmentalize the uncertainties associated with AMT operations so that problems are

resolved at the point at which they occur. As James Thompson (1967: 76) hypothesized, "Under conditions of complexity, when the major components of an organization are reciprocally interdependent, these components will be segmented and arranged in self-sufficient clusters, each cluster having its own domain." The logic of Thompson's hypothesis is illustrated in Herbert Simon's (1973: 649–659) parable of two watchmakers, Hora and Tempus.

> There once were two watchmakers, named Hora and Tempus, who manufactured very fine watches. Both of them were highly regarded, and the phones in their workshops rang frequently—new customers were constantly calling them. However, Hora prospered, while Tempus became poorer and poorer and finally lost his shop. What was the reason?
>
> The watches the men made consisted of about 1,000 parts each. Tempus had so constructed his that if he had one partly assembled and had to put it down–to answer the phone, say—it immediately fell to pieces and had to be reassembled from the elements. The better the customers liked his watches, the more they phoned him and the more difficult it became for him to find enough uninterrupted time to finish a watch.
>
> The watches that Hora made were no less complex than those of Tempus. But he had designed them so that he could put together subassemblies of about ten elements each. Ten of these subassemblies, again, could be put together into a larger subassembly; and a system of ten of the latter subassemblies constituted the whole watch. Hence, when Hora had to put down a partly assembled watch in order to answer the phone, he lost only a small part of his work, and he assembled his watches in only a fraction of the man-hours it took Tempus.

Thus, compartmentalization makes complex systems less prone to disruption because they are composed of stable subsystems, which, in turn, also are composed of smaller stable subsystems.

Compartmentalizing uncertainty in organizations is often accomplished by using workflow as a criterion for organizing subunits instead of function. This means that many or all the manufacturing and staff functions associated with producing a component or product are incorporated within a subunit, instead of being spread across several functional subunits. For example, Allen-Bradley—a manufacturer of motor contractors and control relays—redesigned its manufacturing operations by workflow when implementing a computer-integrated manufacturing system (CIM).

> Personnel were given broad jobs and operated as a team. The line was tended by six operators per shift. Each of the line operators had primary responsibility for part of the system, but all covered for one another, and any operator would respond to an alarm in any part of the system. Operators were

> expected to learn one area and rotate through the other five over a two-year period. Operators also had other responsibilities, including administrative and material-handling duties. The teams met at the beginning of each shift to talk about schedule, quality, and any problems encountered the previous day.
>
> Departing from the traditional pattern, two maintenance personnel were permanently assigned to the CIM unit. Line operators performed minor maintenance, such as replacing drives and clearing jams on the line, and learned from the maintenance employees. (Walton, 1989: 121)

Employees in such work units need to be multiskilled because of the variety of tasks performed. They also need highly developed analytical skills because of the complexity of their jobs. As Buchanan and Bessant (1985: 303) noted, such employees have to understand:

> 1. the process—its layout, sequence of events and interdependencies; 2. the product—its key characteristics and variability of raw materials; 3. the equipment—their functions, capabilities and limitations; 4. the controls—their functions, capabilities and limitations, and the effects of control actions on performance.

The overall effect is to transform what had once been a set of highly specialized jobs into semiprofessional positions (Zuboff, 1988).

Effective performance of expanded responsibilities requires that operational decision-making authority be decentralized to production employees because they possess the expertise to operate and maintain the AMT (Dean & Susman, 1989). With the expertise to recognize problems and the authority to solve them, these employees can diagnose problems, generate solutions, and implement these solutions more quickly than if problems had to be referred up the organizational hierarchy for resolution. This style of problem solving enables production employees "to draw on their experience and understanding of the production process and to be flexible in the use of their skills to create innovative solutions for cost, quality, and efficiency problems at the point of production" (Giordano, 1988: 176). Thus, the overall effect of locating expertise and information access at lower hierarchical levels creates opportunities for continuous organizational learning (Hirschhorn, 1984; Walton, 1989; Zuboff, 1988). This pattern of coordination and control increases the flexibility and speed with which an organization can detect and respond to unforeseen problems and opportunities.

Although workflow subunit grouping compartmentalizes many of the uncertainties created by an AMT, residual uncertainties remain because of the need for cooperation and coordination across subunit boundaries (e.g., between professional groups that are designing and implementing new products and processes) (Dean & Susman, 1989; National Research

Council, 1986). Interdependence across functional boundaries (e.g., among design, engineering, and manufacturing) is amplified by the increasing emphasis on producibility and product quality, customization for specific customer needs, and shorter product life cycles, which are reflected in practices such as concurrent engineering and design for manufacturability (Dean & Susman, 1989; Ettlie, 1988). The resulting interdependencies require mutual adjustment across subunit boundaries through the increased use of integrating mechanisms—such as liaison positions, task forces and standing committees, and cross-functional teams (Buitendam, 1987; Dean & Susman, 1989). The use of such integrating mechanisms further reduces reliance on vertical coordination and control mechanisms, increasing the flexibility and speed of coordination. In Burns and Stalker's (1961: 121) terms, the effect is the development of highly organic structures.

These organic structures appear to be the key to gaining AMTs' flexibility benefits. Research findings suggest that the relationship between organization structure and AMT benefits may be misstated because some studies show that the benefits ascribed to AMTs are as much an outcome of flexible structures as of AMTs. For example, a study of 50 automobile plants in North America, Japan, and Europe by the MIT International Motor Vehicle Program found that plants using traditional technology often outperformed those with AMTs. Of the North American plants studied, Krafcik (1988) reported that traditional facilities with levels of programmable automation that were lower than the world average—such as the GM/Toyota NUMMI joint venture—had higher levels of productivity than more AMT-intensive plants. The factor that most influenced productivity was the organization of work. Plants having "lean" production systems—those in which the workers had broadly defined jobs that emphasized quality and teamwork coupled with just-in-time manufacturing practices—were more productive than those that had more traditional hierarchical, mechanistic structures with highly specialized production jobs and large inventories. Krafcik (1988: 51) concluded "that expensive flexible automation is not a prerequisite to high performance—it can come later (if at all), after the appropriate organizational groundwork has been completed." Another study of 39 FMS installations by Ingersoll Engineers found that an average of 40 percent of the benefits ascribed to FMS were achieved *before* implementation because of changes in management and the reorganization of work (cited in Bessant, 1985). Similarly, Bessant and Lamming (1987) reported that many of the firms in their study estimated the relative contribution of organizational changes to gained benefits during implementation to be between 40 percent and 70 percent.

Flexible structures, coupled with AMTs, can increase productivity. However, unlike their control-oriented counterparts, potential labor savings come as much from decreased overhead as from reductions in production personnel. Enlarged jobs and subunits organized by workflow

enable production employees to assume many staff and supervisory responsibilities, reducing the need for these personnel. Moreover, flexible structures increase the likelihood that adopting organizations will gain AMTs' flexibility benefits. As the previous section shows, broader jobs, enhanced communication, and decentralized decision making increase the potential for the flexible use of AMTs, improving an organization's ability to respond quickly to changing product requirements and market conditions.

Employing a flexibility-oriented design strategy does have costs compared to the control-oriented approach. Organizations that implement flexible structures typically incur higher training costs, higher wages for production employees, and higher implementation costs associated with redesigning an organization into a more flexible configuration than is the case for the control-oriented strategy. However, the literature suggests that these costs are necessary investments because flexible structures appear to be the key to unlocking AMTs' flexibility benefits. Even though it may be possible to implement AMTs using a control-oriented design strategy and gain their productivity benefits, organizations doing so are unlikely to gain AMTs' flexibility benefits because they are not structured for flexible operation.

ORGANIZATIONAL CULTURE AND FLEXIBLE STRUCTURES

If there is growing consensus about the relationship between organizational structure and AMTs' benefits, why do so many organizations fail in their attempts to implement AMTs and so few gain their flexibility benefits? The literature often alludes to the constraining effects of an organization's culture as a major barrier to AMT implementation. An organization's culture is built on the shared values and beliefs of its members (e.g., Hofstede, Neuijen, Ohayv, & Sangers, 1990; Sales & Mirvis, 1984; Schwartz & Davis, 1981) and manifests itself in the ends the organization seeks and the means it uses to attain them. One important "means" is an organization's structure, which reflects a long history of organization-specific, value-based choices. Child (1987a: 171), for example, noted that company traditions "frequently have their origins in the ideology of an entrepreneurial founder who set out both a strategic perspective on the task of the organization and a philosophy on the form of the labor process to accomplish it." Thus, past design choices are likely to influence the type of job design and coordination and control strategies chosen when implementing a new technology (Kelley, 1986). Similarly, Bartlett and Ghoshal (1989) showed how an organization's administrative heritage and ingrained management norms constrain an organization's ability to reconfigure itself. In short, understanding the relationship between an organization's culture and the design choices its managers make can provide greater insight into the AMT implementation process.

The Competing Values Model

Quinn's (1988; Quinn & Rohrbaugh, 1981, 1983) competing values model provides one means of examining how different value orientations underlying organization cultures affect design choices. The model was developed to explain differences in the values underlying models of organizational effectiveness. Quinn and Rohrbaugh's (1981, 1983) research showed that models of organizational effectiveness could be distinguished along two axes reflecting different value orientations. These two axes form a four-cell model of value systems in which each cell has a different means-end emphasis. One axis is a flexibility-control dimension reflecting preferences about organizational structuring. Flexibility-oriented value systems emphasize decentralization and differentiation; control-oriented value systems emphasize centralization and integration. The second axis is an internal-external focus dimension that reflects whether organizations' value systems emphasize the maintenance of an organization's sociotechnical system or the improvement of its competitive position within the environment. The resulting quadrants parallel four major theoretical streams in the organizational effectiveness literature. (The underlying theory base of each quadrant is outlined in Quinn & Rohrbaugh, 1983.)

Quinn and Kimberly (1984: 298) subsequently argued that the competing values model could be used to "explore the deep structures of organizational culture, the basic assumptions that are made about such things as the means to compliance, motives, leadership, decision making, effectiveness values and organizational forms." They also noted that "no organization is likely to reflect only one [value system]. Instead . . . , we would expect to find combinations of values, with some being more dominant than others" (Quinn & Kimberly, 1984: 300), which is consistent with the majority of the literature that portrays organizations as multicultural phenomena (e.g., Gregory, 1983; Louis, 1983; Reynolds, 1986; Tichy, 1982). In other words, individual organizations are likely to embrace different mixtures of values that are reflected in their desired ends and in the means used to attain them, such as their structural designs and mechanisms of coordination and control. The predicted relationships of these value systems with other organizational phenomena are summarized in Table 1.

The first quadrant—the group value system—is based on norms and values associated with affiliation. Individual compliance with organizational mandates flows from trust, tradition, and members' long-term commitment to the organization. It emphasizes the development of human resources and values member participation in decision making. The second quadrant—the developmental value system—is permeated by assumptions of change. Individuals are motivated by the importance or ideological appeal of the task being undertaken. Growth, external legitimacy, and resource acquisition are emphasized ends. The third quad-

TABLE 1
The Competing Values Model: Four Value Systems and Their Characteristics[a]

Value Systems	Group	Developmental	Hierarchical	Rational
Value Dimensions				
Flexibility/Control	Flexibility	Flexibility	Control	Control
Internal External Focus	Internal	External	Internal	External
Means	Cohesion, morale	Adaptability, readiness	Information management, communication	Planning, goal setting
Ends	Development of human resources	Growth, resource acquisition	Stability, control	Production, efficiency
Organizational Characteristics				
Compliance	Affiliation	Ideology	Rules	Contract
Motivation	Attachment	Growth	Security	Competence
Leadership	Concerned, supportive	Inventive, risk taking	Conservative, cautious	Directive, goal oriented
Technology	Craft	Nonroutine	Routine	Engineering
Organizational Form	Clan	Adhocracy	Hierarchy	Market

[a]"From Paradox, Planning, and Perseverance: Guidelines for Managerial Practice" by J. R. Kimberly and R. E. Quinn. In *Managing Organizational Transitions* (p. 299) by J. R. Kimberly and R. E. Quinn (Eds.), 1984, Homewood, IL: Dow Jones-Irwin and from "Environments, Organizations, and Policymakers: Toward an Integrative Framework" by R. H. Hall and R. E. Quinn. In *Organization Theory and Public Policy* (p. 293) by R. H. Hall and R. E. Quinn (Eds.), 1983, Beverly Hills, CA: Sage. Adapted by permission.

rant—the hierarchical value system—reflects the values and norms associated with bureaucracy. Quinn and Kimberly (1984) noted that this value system is permeated with assumptions of stability. Individuals comply with organizational mandates because roles are formally stated and enforced through rules and regulations. The fourth quadrant—the rational value system—is permeated by assumptions of achievement, and its primary objectives are planning, productivity, and efficiency. Individuals are motivated by beliefs that competent performance leading to desired organizational ends will be rewarded.

Values, Structure, and the Implementation of AMTs

Zammuto and Krakower (1991) examined the relationship between organizations' competing values profiles and a number of organizational characteristics. Specifically, they developed survey-based competing

values (CV) profiles for 332 colleges and universities and examined the relationships between the profiles and several different aspects of organizational structure, climate, and strategic orientation. (Their instrumentation is described in the appendix.)

Zammuto and Krakower (1991) found that the flexibility-control dimension of the competing values model was related to different patterns of coordination and control. Group and developmental value scores emphasizing flexibility were negatively correlated with formalization and long-term planning (Table 2), two aspects of hierarchical coordination and control systems. The group score was also negatively correlated with centralization. In contrast, hierarchical and rational value scores emphasizing control were positively associated with the use of hierarchical coordination and control mechanisms. The hierarchical value score positively correlated with formalization and long-term planning; the rational value score positively correlated with centralization. Zammuto and Krakower also found an association between value emphases and organization size and ownership. Larger organizations were more likely to emphasize control-oriented values than were smaller organizations. Similarly,

TABLE 2
Correlations Between Cultural Types and Organizational Characteristics, Climate, and Strategic Orientation[a]

	Cultural Type Score			
	Group	Developmental	Hierarchical	Rational
Organizational Characteristics				
Centralization	−.19**	.03	.00	.28**
Formalization	−.14**	−.22**	.42**	.02
Long-term planning	−.09*	−.11*	.18**	.08
Climate				
Trust	.34**	.13**	−.33**	−.36**
Conflict	−.29**	−.15**	.35**	.29**
Morale	.15**	.23**	−.32**	−.18**
Equity of rewards	.34	.04	−.37**	−.51**
Resistance to change	−.12*	−.41**	.52**	.11*
Leader credibility	.21**	.22**	−.36**	−.22**
Scapegoating	−.20**	−.11*	.24**	.21**
Strategy				
Reactive orientation	.21**	−.61**	.41**	−.08
Proactive orientation	−.26**	.73**	−.47**	.08

$N = 332$
*$p < .05$
**$p < .01$
[a] From "Quantitative and Qualitative Studies in Organizational Culture" by R. F. Zammuto and J. Y. Krakower, 1991, *Research in Organizational Change and Development*, 5, p. 95. Copyright 1991 by *Research in Organizational Change and Development*. Reprinted by permission.

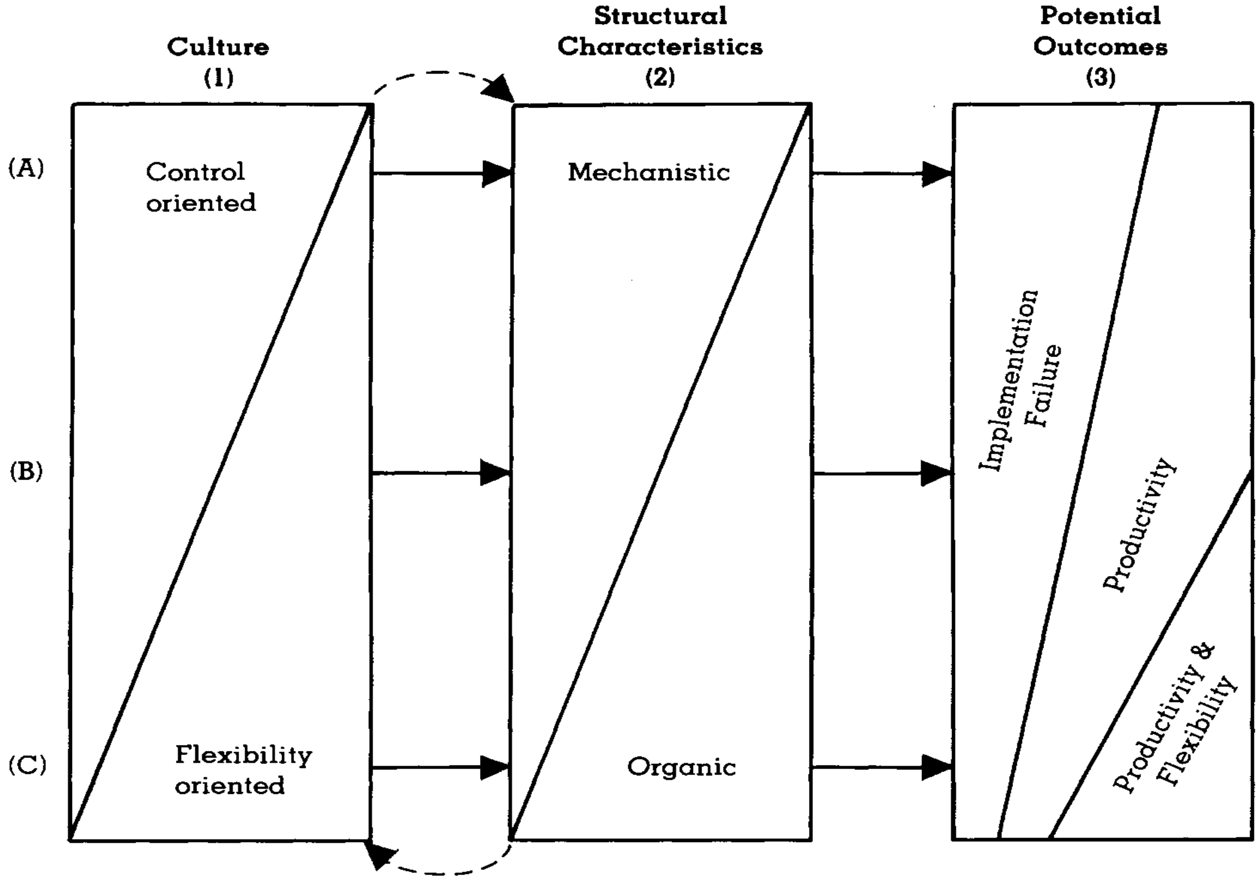
public colleges and universities were more likely to emphasize control-oriented values than were private institutions, which were more likely to emphasize flexibility-oriented values.

These findings fit well with research on organizational factors affecting choices about whether organizations pursue a flexibility-oriented design strategy during implementation by enlarging employees' jobs, upgrading skills, and decentralizing operational decision making. For example, Kelley (1990) demonstrated that an organization's size and complexity significantly influenced the odds of whether production employees' jobs were enlarged and their skills upgraded through the decentralization of programming responsibilities. Using logistic regressions, she found that the odds for decentralization and skill upgrading were highest in small, single-plant enterprises—1.7:1; they were the lowest in large plants of large multiplant enterprises—1:5.7. Similarly, after reviewing evidence about job de-skilling versus job enlargement, Wall and Davids (In press) suggested that organization size may be an important contextual factor, with enlargement more likely in small organizations and de-skilling more likely in larger organizations.

Kelley (1990) also examined the effects of seniority systems and the presence of unions on AMT implementation. She found that the odds of decentralizing significant programming responsibilities to production employees were 1.9:1 in nonunion workplaces that did not have a seniority system. The odds decreased with the presence of a union to 1.2:1, and they decreased to 1:3.3 with the presence of both a union and seniority system. These findings are consistent with Lincoln, Hanada, and McBride's (1986) research showing that unionization is positively correlated with centralization. They also are consistent with Mintzberg's (1979) hypothesis that external control stemming from factors such as unionization and government ownership results in centralized decision making. In short, the convergence of results linking culture, structure, and AMT implementation practices suggests that organizations with control-oriented values will pursue a control-oriented design strategy when implementing an AMT. Conversely, organizations with flexibility-oriented values are more likely to pursue a flexibility-oriented design strategy when implementing an AMT.

Figure 1 shows the predicted pattern of relationships among cultural values, structure, and the outcomes of AMT implementation. Column 1 indicates the relative balance of values in an organization's culture along the control-flexibility axis of the competing values model. For example, an organization beginning the implementation process at point (A) would have a culture emphasizing control-oriented hierarchical and/or rational values. Conversely, an organization at point (C) would have a culture emphasizing flexibility-oriented group and/or developmental values. Consistent with Zammuto and Krakower's (1991) results, and as is shown in column 2, we would expect that Organization A would have a mechanistic structure, whereas Organization C would have an organic structure.

FIGURE 1
Relationships Among Culture, Structure, and AMT Outcomes



The implementation of AMTs within the context of these organizations' existing structures is likely to result in different outcomes, as is indicated in column 3. The range of potential outcomes for Organization A includes implementation failure and productivity gains. Because highly mechanistic structures are not conducive to coping with the complexities and uncertainties of AMT operations, implementation failure is seen as a more likely outcome than productivity gains. And because a highly mechanistic structure prevents the flexible operation of an AMT, flexibility gains are not seen as a potential outcome. The potential outcomes for Organization C include implementation failure, productivity gains, and productivity and flexibility gains. Because organic structures facilitate the implementation process by compartmentalizing uncertainties and decentralizing operational decision making, implementation failure is seen as being less likely than for mechanistic structures. Also, because organic structures are the key to flexible AMT operation, productivity and flexibility gains are seen as the most likely outcome.

Organization B represents an intermediate case and probably is more representative than either of the extremes. Organizations' cultures that combine flexibility- and control-oriented values are likely to have struc-

tures with both mechanistic and organic characteristics (Zammuto & Krakower, 1991). In this instance, implementation failure is less likely than for organizations implementing AMTs with highly mechanistic structures, but the range of outcomes is still restricted compared to organizations with highly organic structures. In short, we expect that the relative balance of flexibility- and control-oriented values and their manifestation through an organization's structure will affect the likelihood of implementation success and of the benefits gained. This reasoning leads to the following hypotheses:

> *Hypothesis 1: The greater an organization's emphasis on control-oriented values, the more likely it will experience implementation failure (i.e., be unable to get the system up and running reliably).*

> *Hypothesis 2: The greater an organization's emphasis on flexibility-oriented values, the more likely it will gain AMTs' productivity and flexibility benefits.*

This pattern fits reports of AMT implementation failure and success fairly well. As Bessant and Lamming (1987: 360) noted:

> Traditionally production has been characterised by a culture which emphasises things like stability, bureaucratic procedure ("doing things by the book"), specialisation and division of responsibility, and so on—what Burns and Stalker called "mechanistic" in their pioneering studies.

Research findings support this view. For example, the Commission on the Skills of the American Workforce (1990) research indicated that 95 percent of U.S. employees work in organizations that have highly specialized jobs (Stewart, 1990). Similarly, Kelley (1989: 238–239) reported that 38.8 percent of workers in machining occupations worked in plants where programming was strictly a white-collar domain, and 42.6 percent of these workers were in plants where programming responsibilities were at least occasionally performed by blue-collar workers. Only 18.6 percent of these workers were in plants where programming responsibilities were solely in the blue-collar domain, indicating that manufacturers with decentralized operational decision making appear to be the distinct minority.

Within this context, the large-scale studies of AMT implementation reviewed previously report failure rates of around 50 percent. Studies reporting implementation success are not uncommon, but the organizations, in many cases, appear to have been selected because they had successfully implemented AMTs. Furthermore, most of the reported benefits in these studies are productivity related (i.e., increased machine utilization, decreased work-in-process inventories, reduced unit cost, and shorter lead times); relatively few studies report increased flexibility. Research reporting significant flexibility gains, such as the Deere & Co.,

Allen-Bradley, and National Research Council case studies, are less frequent (although more widely cited) and were conducted in organizations reporting significant workplace reforms that made their structures more flexible. Similarly, Jaikumar's (1986) comparison of Japanese and U.S. manufacturers showed that Japanese organizations gaining AMTs' flexibility benefits also employed flexible structures. In contrast, U.S. organizations experienced increased productivity, but not flexibility. They also employed more control-oriented structures.

In other words, the pattern suggests that the majority of manufacturing organizations, particularly in the United States and Europe, have mechanistic structures that impede the implementation of AMTs and that many, as a result, experience implementation failure. Organizations with mechanistic structures that get AMTs up and running reliably typically experience gains in productivity but not flexibility because they are not designed for flexible operation. Relatively few manufacturing organizations appear to have organic structures that allow flexible AMT operation. Although relatively small in number, these organizations appear to be the most likely to gain both AMTs' productivity and flexibility benefits.

Culture, Climate, and the Learning Environment

The role an organization's culture plays in AMT implementation extends beyond that of guiding choices about structure. It also plays an important role in creating the organizational climate within which implementation occurs. Several researchers suggest that the level of employee involvement in an organization can have a major impact on the implementation process. Giordano (1988: 180), for example, noted that "management knows that operators can either perform the basic functions to get a job done or, by working with the information stored in the computer, find faster, less costly and improved production methods." The former behaviors hinder AMT implementation, making it more difficult to get them up and running and making flexible operation unlikely. In contrast, the latter types of behaviors facilitate AMT implementation by promoting continuous learning within an organization (Walton, 1989; Wilson, 1988). The key to doing so, as Zuboff (1988: 184) observed, is "to create organizational environments that support the quality of effort and the kinds of relationships in which intellective competence can be demonstrated."

Hildebrandt (1988) concluded from his study of 12 FMS adoptors that learning behaviors are likely to occur only in "high-trust organizations." Walton (1989) made the same distinction in his discussion of high-compliance versus high-commitment organizations. In high-compliance organizations, employees "are expected to give a fair day's effort for a fair day's pay and management is expected to supervise this bargain in a firm but fair manner" (Walton, 1989: 81). In high-commitment organizations, the relationship between labor and the organization is expanded "well beyond the traditional arrangement. The employee becomes committed to

the organization and its goals, and this is matched by an additional commitment by the employer to the employee's welfare" (Walton, 1989: 81).

Zammuto and Krakower's (1991) research indicates that an organizational climate supportive of this expanded relationship is more likely to exist in organizations with cultures emphasizing flexibility-oriented values than in those emphasizing control-oriented values. They found that group and developmental value scores were positively correlated with trust, morale, perceived equity of rewards, and leader credibility, and these scores were negatively correlated with conflict and resistance to change (Table 2). Hierarchical and rational value scores, in contrast, were negatively correlated with trust, morale, perceived equity of rewards, and leader credibility, but they were positively correlated with conflict and resistance to change.

In terms of Figure 1, this means that an organization beginning the AMT implementation process at point (C) has a much less daunting change process to cope with than an organization beginning at point (A) because a supportive climate already exists. If managers in Organization A want to increase the likelihood of implementation success, they have to cope with the difficulties of both extensive organizational *and* technological change. In other words, developing a structure and climate supportive of AMT implementation while implementing a new technology is more difficult than implementing the technology alone. One way to reduce the stresses accompanying extensive change is to stagger the implementation of organization and technological changes. Giordano (1988) and Walton (1989), for example, noted that organizations that have already undergone work reforms, such as quality of work life programs, are better prepared for AMT implementation. Thus, we hypothesize that:

> *Hypothesis 3: Organizations emphasizing control-oriented values can decrease the likelihood of implementation failure by increasing cultural and structural flexibility prior to technology implementation.*

Major cultural and structural change efforts are costly and time-consuming because of the need to build trust, develop skills, and overcome resistance. Consider the changes that an organization has to make in moving from a control-oriented culture with a mechanistic structure to a flexibility-oriented culture with an organic structure. It takes time to resocialize employees to values and beliefs that support a more flexible, decentralized structure. Preparing for decentralization is time-consuming and costly because it requires that lower level employees, supervisory personnel, and middle managers be retrained in the knowledge, skills, and abilities needed to carry out their new roles. And these changes disrupt existing power and status networks, making significant resistance likely as well as costly and time-consuming to overcome (Child, 1987b; Child, Ganter, & Kieser, 1987; Nadler & Robinson, 1987).

Coupled with other, noncultural factors that create structural inertia—such as sunk costs, legal and contractual barriers to change, stable exchange relationships with other organizations, and so on (Hannan & Freeman, 1984)—it is not surprising that many control-oriented organizations attempt to implement AMTs within their existing organizational contexts. These factors also explain why many manufacturers introduce AMTs into greenfield sites instead of existing plants (Hirschhorn, 1984). There is less history and fewer barriers to overcome.

Organizations with control-oriented cultures and structures that choose to undergo such transformations usually start with small initiatives because of their poor organizational climates, which are characterized by low trust, poor morale, and high levels of conflict. Common first steps include developing joint labor-management steering committees, initiating modest retraining programs, and introducing small-scale workplace reforms such as quality circles. Small successes are then used to build a more supportive climate for the introduction of larger changes such as job and work unit redesign, decentralized operational decision making, and so on. In essence, moving toward a more flexible culture/structure configuration is an iterative process where structural and cultural change interact, as the feedback loop between culture and structure in Figure 1 indicates. It takes time for these processes to occur. Therefore, for control-oriented organizations choosing to increase the likelihood of implementation success by making their cultures and structures more flexible, we hypothesize that:

> *Hypothesis 4: The length of the implementation process prior to gaining significant benefits will be longer for organizations emphasizing control-oriented values than for organizations emphasizing flexibility-oriented values.*

Retraining employees is critical to the success of developing more flexible cultures and structures. Training programs are a primary mechanism through which organizations resocialize employees to new organizational values. They also signal an organization's desire for greater employee involvement and its reciprocal commitment to increasing employee welfare (Walton, 1989). Moreover, enlarged and more complex production jobs require fundamental reading, math, and computer literacy skills; the ability to learn and reason; and the ability to draw conclusions, to express ideas, and to exercise judgment. Expanded coordination and control responsibilities demand additional interpersonal skills such as communication, conflict resolution, and negotiation capabilities.

As a result, upgrading employee skills to the point where employees can effectively operate an AMT can be expensive (Rothwell, 1987). For example, a Chrysler assembly plant in Belvidere, Illinois, invested $25 million over three years when 5,000 employees were retrained in preparation for the implementation of a computer-integrated assembly system.

A significant amount of this money was spent on remedial education in the areas such as math skills, fundamental reading, and computer literacy. Organizations also incur significant ongoing training costs after their initial investment because of the need to continually update employee knowledge and skills (Nemetz & Fry, 1988). For example, IBM's computer-integrated manufacturing facility in Austin, Texas, spends more than 5 percent of its annual payroll (not including lost wages) on training. Most organizations spend less than 1 percent of total payroll on training costs (Commission on the Skills of the American Workforce, 1990).

Because production employees in highly specialized jobs common to control-oriented manufacturing organizations typically do not possess needed skills, substantial and costly upgrading of workers' capabilities is required to move toward more flexible cultures and structures. The size of the initial investment and ongoing training costs suggests that organizations that implement AMTs need to view their employees as assets to be developed rather than as easily replaced components of the production process. As Rothwell (1987: 65) noted, such a view is related to "the philosophy or culture of an organization; that is, the extent to which there is an explicit concern for employee development and welfare which is seen as integral to, rather than subordinate to, a concern with profit maximization and the bottom line." The logic of the competing values model suggests that concerns for employee development and welfare are more characteristic of flexibility-oriented values (especially the group value system) than of control-oriented values. Therefore, for control-oriented organizations choosing to increase the likelihood of implementation success by making their cultures and structures more flexible, we hypothesize that:

> *Hypothesis 5: The greater the emphasis on control-oriented values, the greater the cost of the organizational changes necessary to gain AMTs' flexibility benefits.*

Cultural Strength and Internal/External Focus

Two characteristics of organizations' cultures are likely to affect the relationships described in Hypotheses 1, 2, and 3. One is the extent to which individuals' perceptions of their organizations' cultures vary. Little variation is likely to result in cultures where behavioral norms and beliefs in the "rightness" of existing arrangements are deeply ingrained, making it more difficult to change them. Zammuto and Krakower (1991) used intraclass correlations (ICC_1) to examine the homogeneity in perceptions of organizations' cultures and found considerable variability. The effect on AMT implementation will depend on an organization's value emphasis and it will accentuate the relationships (i.e., further increase or decrease the likelihood) of outcomes predicted in Hypotheses 1, 2, and 3 as follows:

The less the variability in an organization's members' perceptions of its culture (i.e., the higher the ICC_1):

> *Hypothesis 6a: the more likely that an organization emphasizing control-oriented values will experience implementation failure.*

> *Hypothesis 6b: the more likely that an organization emphasizing flexibility-oriented values will gain AMTs' productivity and flexibility benefits.*

> *Hypothesis 6c: the less likely that an organization emphasizing control-oriented values can enhance the likelihood of implementation success by changing its culture and structure.*

A second aspect of an organization's culture—the extent to which it is internally focused versus externally focused—may affect the types of AMT benefits it seeks. Hayes and Wheelwright (1984), for example, noted that manufacturing strategies are based on corporate values that guide organizations in making trade-offs among competing performance emphases such as cost, quality, delivery, and flexibility. Zammuto and Krakower (1991) found that the CV model's internal-external focus axis differentiated between whether organizations' strategic orientations were reactive or proactive (Table 2). Group and hierarchical value scores, which emphasize an internal focus, were positively correlated with a reactive strategic orientation and negatively correlated with a proactive orientation. Conversely, the developmental value score, which emphasizes an external focus, was positively correlated with a proactive strategic orientation and negatively correlated with a reactive strategic orientation. The correlations between rational scores and strategic orientation, however, were not significant.

Many factors affect organizations' decisions to adopt AMTs, for example, the rate of technological change within an industry, the length of product life cycles, and batch size. However, managers' perceptions of industry conditions and subsequent strategic choices are likely to be shaped by their organizations' cultures. Zammuto and Krakower's (1991) results suggest that for organizations in similar industry environments, those emphasizing internally focused values are more likely to adopt AMTs for their productivity benefits, whereas those emphasizing externally focused values are more likely to adopt AMTs for their productivity *and* flexibility benefits. We hypothesize that;

> *Hypothesis 7: Given similar industry environments, organizations emphasizing internally focused values are less likely to actively seek AMTs' flexibility benefits than organizations emphasizing externally focused values.*

The practical implication is that managers in control-oriented organizations should carefully assess why they are considering adopting an AMT. If they are interested only in productivity gains, or if they want the flexibility benefits but estimate that the cultural and structural changes needed to enhance flexibility are unlikely, they may be better off adopting dedicated or fixed-cycle automation hardware instead of AMTs. Such equipment can increase productivity and typically is less expensive than AMT hardware. It also is less complex, which makes implementation success more feasible within the context of a control-oriented organization (Child, 1987b).

One caveat about AMT itself should be made. Our analysis assumes that an organization is implementing an extensive AMT that automates and closely integrates manufacturing and support activities. In reality, the movement toward full integration is in its infancy with many organizations adopting individual AMT components. For example, one organization may begin its experiences with AMT by implementing a computer-aided design system, whereas another organization might add a flexible manufacturing cell. In both instances, this implementation creates "islands of automation" within an organization (Bessant & Haywood, 1988; Nemetz & Fry, 1988), where the technology automates within a function but does not integrate across functions. Because islands of automation create fewer operational complexities than full-scale integration, organizations will find them less difficult to implement. As a result, we expect that the likelihood of implementation failure predicted in Hypothesis 1 will decrease as the extent to which an AMT integrates across functions and subunit boundaries decreases, making productivity gains more probable. We hypothesize the following relationship:

> *Hypothesis 8: The less an AMT integrates across functions and subunit boundaries, the more likely a control-oriented organization will gain productivity benefits.*

CONCLUSION

Examining the roles of organization design and culture in successful AMT implementation may yield both theoretical and practical information. On the theoretical side, using this framework to study AMT implementation should provide greater insight into the relationship between technology and structure. For example, it appears that advanced manufacturing technologies and their underlying information systems expand the magnitude of benefits traditionally associated with different organization structures. On one hand, they can amplify the flexibility and speed of response possible from organic structures. On the other hand, they can increase the degree of managerial control gained through mechanistic structures (Chalykoff & Kochan, 1989; Zuboff, 1988). Research on the relationships between organization structure and microprocessor-based tech-

nologies should increase our understanding of the technology-structure relationship beyond that gained in the 1960s and 1970s—before microprocessor-based technologies became pervasive.

On a practical side, the findings of such research can have significant value for managers as they prepare for AMT implementation. These findings could help managers assess the likelihood that implementation will be successful, whether an organization is likely to gain AMTs' productivity and flexibility benefits, the extent to which organizational change would enhance implementation success, the costs of organizational change, and the length of time it may take for implementation. Such information is important because organizations make significant investments of time, money, and personnel when they adopt AMTs. A better understanding of the relationships among structure, culture, and AMT implementation may increase their ability to make wise choices regarding how these resources are used. These decisions are also important from a societal perspective. As the Commission on the Skills of the American Workforce (1990) concluded, the long-term well-being of these organizations, the individuals they employ, and our economic system demand that these challenges be met successfully.

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APPENDIX

Competing Values Instrumentation

The survey instrument below was used to develop competing values (CV) profiles for individual organizations in Zammuto and Krakower's (1991) study of 332 colleges and universities. Respondents were asked to indicate the extent to which their institution evidenced characteristics associated with each of the four value systems along four dimensions: institutional character, institutional leadership, institutional cohesion, and institutional emphases. The term *institution* can be changed to better reflect the unit of analysis, whether it be an organization, a division, or a work unit. A revised version of the instrument is available from the first author.

Scoring

A CV profile was devised for each respondent by averaging his or her ratings for each value system across the four dimensions (i.e., 'A' scenarios = group value system, 'B' = developmental, 'C' = hierarchical, and 'D' = rational). This procedure produced a profile reflecting each respondent's perception of the relative mix of values underlying his or her organization's culture. An institutional CV profile was then obtained by averaging each score across respondents.

Psychometric Characteristics

Coefficient alphas for each of the four value system scales were: group = .82, developmental = .83, hierarchical = .67, and rational = .78. Intraclass correlations at the 25th, 50th, and 75th percentiles were .22, .47, and .66, respectively. A full report of the instrument's psychometric properties is contained in Zammuto and Krakower (1991).

Instrument

Instructions: These questions relate to the type of organization that your institution is most like. Each of these items contains four descriptions of institutions of higher education. Please distribute 100 points among the four descriptions depending on how similar the description is to your institution. None of the descriptions is any better than the others; they are just different. For each question, please use all 100 points.

> *For example: In question 1, if Institution A seems very similar to mine, B seems somewhat similar, and C and D do not seem similar at all, I might give 70 points to A and the remaining 30 points to B.*

1. Institutional Character (Please distribute 100 points)

——— Institution A is a very *personal* place. It is a lot like an extended family. People seem to share a lot of themselves.

——— Institution B is a very *dynamic and entrepreneurial* place. People are willing to stick their necks out and take risks.

——— Institution C is a very *formalized and structured* place. Bureaucratic procedures generally govern what people do.

——— Institution D is very *production-oriented*. A major concern is with getting the job done. People aren't very personally involved.

2. Institutional Leader (Please distribute 100 points)

——— The head of Institution A is generally considered to be a *mentor, a sage, or a father or mother figure.*

——— The head of Institution B is generally considered to be an *entrepreneur, an innovator, or a risk taker.*

——— The head of Institution C is generally considered to be a *coordinator, an organizer, or an administrator.*

——— The head of Institution D is generally considered to be a *producer, a technician, or a hard driver*.

3. Institutional "Glue" (Please distribute 100 points)

——— The glue that holds Institution A together is *loyalty and tradition*. Commitment to this institution runs high.
——— The glue that holds Institution B together is *commitment to innovation and development*. There is an emphasis on being first.
——— The glue that holds Institution C together is *formal rules and policies*. Maintaining a smooth running operation is important here.
——— The glue that holds Institution D together is the emphasis on *tasks and goal accomplishment*. A production orientation is commonly shared.

4. Institutional Emphases (Please distribute 100 points)

——— Institution A emphasizes *human resources*. High cohesion and morale in the institution are important.
——— Institution B emphasizes *growth and acquiring new resources*. Readiness to meet new challenges is important.
——— Institution C emphasizes *permanence and stability*. Efficient, smooth operations are important.
——— Institution D emphasizes *competitive actions and achievement*. Measurable goals are important.

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